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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 09/516,653 | 03/01/2000 | Brian DOYLE | P8123 | 3216 |

8791 7590 11/06/2003

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| EXAMINER |
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BEREZNY, NEAL

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| ART UNIT | PAPER NUMBER |
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2823

DATE MAILED: 11/06/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/516,653

Applicant(s)

DOYLE, BRIAN

Examiner

Neal Berezny

Art Unit

2823

pw

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 08 April 2003.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-13, 15-26 and 39-50 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-10, 12, 16-26, 40, 42-44 and 48-50 is/are rejected.
- 7) ☒ Claim(s) 11, 13, 15, 41 and 45-47 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☒ The proposed drawing correction filed on 22 February 2002 is: a) ☒ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other:

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 4/8/03 has been entered.

Specification

2. Applicant's amendment to the specifications has overcome Examiner's objection.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

4. Claims 22, 24, and 25 are rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for a process to build a quantum wire device, does not reasonably provide enablement for a process to build a classical semiconductor wire device. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make the invention commensurate in scope with these claims. Nowhere in the specifications is there a teaching to apply applicant's invention to anything other than a quantum wire device. The claims cannot be broader than the specifications and the claims include the

possibility of using the applicant's invention for a classical semiconductor device where the channel is bigger than the mean free path of the semiconductive electron flow.

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

6. Claims 1, 5, 10, 48, and 49 are rejected under 35 U.S.C. 102(e) as being clearly anticipated by Doyle et al. (6,063,688).

The applied reference has a common assignee with the instant application.

Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art under 35 U.S.C. 102(e). This rejection under 35 U.S.C. 102(e) might be overcome either by a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this application and is thus not the invention "by another," or by an appropriate showing under 37 CFR 1.131.

7. Doyle teaches a method of forming a device comprising: patterning a first oxide upon a substrate; fig.4, el.130, forming a first nitride spacer mask upon the first oxide; fig.7, el.140, forming a first oxide spacer mask upon the first nitride spacer mask; fig.9, el.150, forming a second nitride spacer mask upon the first oxide spacer mask; fig.11, el.160, forming a plurality of channels in the substrate that are aligned to the second

nitride spacer mask; fig.22, el.200, 250, forming a gate layer over the plurality of channels, wherein each of the plurality of channels is narrower than the mean free path of semiconductive electron flow therein; fig.40, el.340, col.10, ln.67 to col.11, ln.5, wherein forming a plurality of channels in the substrate that are aligned to the second nitride spacer mask comprises: performing a gate etch with the second nitride spacer masks; col.9, ln.1-7, wherein the substrate comprises monocrystalline silicon, and wherein the plurality of channels is spaced apart by a trench that is at least as wide as each of the channels; col.7, ln.59-62, forming a plurality of semiconductive channels into a first material, each of the plurality of semiconductive channels comprising a channel width having a mean free path smaller than electron flow, the plurality of semiconductive channels being formed by forming at least two spacer masks, the at least two spacer masks comprising second and third materials that can be etched with an etch chemistry selective to each other and also selective to the first material; wherein the first material is a silicon material, the second material is a nitride material, and the third material is an oxide material; fig.22, el.250, col.8, ln.57-63.

Claim Rejections - 35 USC § 103

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

9. Claims 2-4, 6-9, 12, 16-26, 39-40, 42-44, and 50 are rejected under 35 U.S.C. 103(a) as being obvious over Doyle et al. (6,063,688) as applied above to claims 1, 5, 10, 48, and 49.

10. The applied reference has a common assignee with the instant application.

Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art only under 35 U.S.C. 102(e). This rejection under 35 U.S.C. 103(a) might be overcome by: (1) a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this application and is thus not an

invention "by another"; (2) a showing of a date of invention for the claimed subject matter of the application which corresponds to subject matter disclosed but not claimed in the reference, prior to the effective U.S. filing date of the reference under 37 CFR 1.131; or (3) an oath or declaration under 37 CFR 1.130 stating that the application and reference are currently owned by the same party and that the inventor named in the application is the prior inventor under 35 U.S.C. 104, together with a terminal disclaimer in accordance with 37 CFR 1.321(c). For applications filed on or after November 29, 1999, this rejection might also be overcome by showing that the subject matter of the reference and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person. See MPEP § 706.02(I)(1) and § 706.02(I)(2).

11. Doyle teaches wherein forming a first nitride spacer mask comprises: forming a first nitride layer over the first oxide; and performing an anisotropic etch upon the first nitride layer; and wherein forming a first oxide spacer mask upon the first nitride spacer

mask comprises: forming a first oxide layer over the first nitride spacer mask; and performing an anisotropic etch upon the first oxide layer; and wherein forming a second nitride spacer mask upon the first oxide spacer mask comprises: forming a second nitride layer over the first oxide spacer mask; and performing an anisotropic etch upon the second nitride layer; col.8, ln.32-36, 44-54, 57-60, forming a gate oxide upon the plurality of channels, fig.24, el.270; forming a source at a first terminal end of the plurality of semiconductive channels; forming a second terminal end of the plurality of semiconductive channels; forming a gate layer over the dielectric layer; fig.40, el.350 and 360.

12. Doyle appears not to specifically state that a reactive ion be used to perform the anisotropic etch. It would be obvious to one of ordinary skill in the art at the time of the invention to use the well-known process of reactive ion etching to perform an anisotropic etch so as to have better selectivity and less damage to the structure surface than other processes, such as ion milling.

13. Doyle also teaches wherein the first oxide has a pitch of about three times the first width; col.8, ln.1-13, 52-54 and col.11, ln.1-3, forming an oxide upon the plurality of quantum wires; forming a gate layer over the oxide; and forming a contact that connects with the plurality of channels, wherein the contact has a characteristic third width from about 2 times the first width to about 10 times the first width; fig.40, el.350, 340, and 360; forming a first nitride layer upon the first oxide, wherein the first nitride layer has a characteristic thickness of about one half X; col.7, ln. 60-65, performing a spacer etch upon the first nitride layer and removing the first oxide to form a patterned

first nitride spacer mask; col.8, ln.60-63, forming an oxide layer upon the patterned first nitride spacer mask, wherein the oxide layer has a characteristic thickness of about one fourth X; performing a spacer etch upon the oxide layer and removing the patterned first nitride spacer mask to form a patterned first oxide spacer mask; col.8, ln.1-14, wherein X is in a range from about 20 nm to about 200 nm; col.7, ln.60-65; 42, wherein the semiconductive channel width is formed in a range from less than or equal to about 5 nm to about 30 nm; col.11, ln.1-5; 43; forming a contact that makes electrical connection with one of the terminal ends of the plurality of semiconductive channels

upon a contact landing pad; forming a contact that makes electrical connection with one of the terminal ends of the plurality of semiconductive channels, wherein the contact has a characteristic width in a range from about 200 nm to about 1,000 nm; fig.40, el.350, 340, 360.

14. Doyle appears not to specifically state wherein the first oxide is patterned with a width of about 100 nm and a pitch of about a pitch of about 300 nm or about 320 nm; nor wherein the first width of the oxide structures is approximately between 50nm to 200nm and the quantum wires have a second width that is about one-tenth the first width; nor forming a second nitride layer upon the patterned first oxide spacer mask, wherein the second nitride layer has a characteristic thickness of about one-tenth X; nor wherein a first semiconductive channel of the plurality of semiconductive channels is spaced apart from a second semiconductive channel of the plurality of semiconductive channels by a trench that is less than about five times the semiconductive channel width. It would be obvious to one of ordinary skill in the art at the time of the invention

to modify the dimensions of the structure. A change in size is generally recognized as being within the level of ordinary skill in the art. *In re Rose*, 105 USPQ 237 (CCPA 1955).

15. Doyle does not specifically teach the use of an SOI substrate. It would be obvious to one of ordinary skill in the art at the time of the invention to use a well-known SOI substrate instead of a silicon substrate in order to reduce leakage currents into the substrate.

16. Doyle appears not to teach wherein the plurality of channels comprises a plurality of single-gate quantum wire field effect transistors. It would be obvious to one of ordinary skill in the art at the time of the invention to build a plurality of transistors instead of just one, since it has been held that a mere duplication of a device involves only routine skill in the art. *St. Regis Paper Co. v. Bemis Co.*, 193 USPQ 8.

Allowable Subject Matter

17. Claims 11, 13, 15, 41, 45-47 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. The prior art of record fails to teach a quantum wire device wherein the process includes forming a self-aligned doping region in the monocrystalline silicon beneath the trench; nor wherein the second nitride spacer mask is disposed between the channel and the gate layer. It would not be obvious to one of ordinary skill in the art at the time of the invention to dope the region under the trench nor to maintain the nitride spacer mask when depositing the gate layer because it is not clear the effect of doping the channel would have on the

quantum wire since the dopant contribution of charged carriers would appear not to play a significant role in the quantum properties of the wire. Further, keeping the nitride spacer mask when depositing the gate layer appears to traverse typical practices in semiconductor technology, because it introduces a non-planar surface, which would introduce lithography problems, but in a quantum device, such a structure may facilitate the quantum containment of the electrical particles and would thus be nonobvious.

Response to Arguments

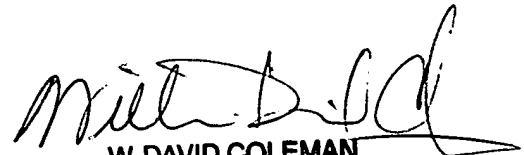
18. Applicant's arguments with respect to claims 1-13, 15-26, and 39-50 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

19. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Neal Berezny whose telephone number is (703) 305-1481. The examiner can normally be reached on M-F 9:00 - 5:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on (703) 306-2794. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.


W. DAVID COLEMAN
PRIMARY EXAMINER

NB
October 28, 2003